PROCESS FOR CLARIFYING AND DEODORIZING WATER COMPRISING SUSPENDED SOLIDS

FIELD OF THE INVENTION

The present invention relates generally to the field of water treatment systems.

BACKGROUND OF THE INVENTION

According to municipalities, government agencies, environmentalists and the public in general, odour and potential pollution sources emanating from livestock facilities are the main issues that need to address in order to sustain their development. The most intense source of odour from livestock facilities occurs during manure handling and land application. Typically, most commercial livestock operations feature under-floor manure storage pits. These pits are situated beneath the barns and store the manure until the manure is emptied from the pit and transferred to mid-term storage lagoons. The odour problem that arises when the manure is stored in such a manner is a result of the anaerobic conditions that exist in the lagoon. Typically, aerobic conditions exist only in the layer of manure that is in contact with air and the malodorous gases produced anaerobically beneath this layer gradually diffuse to the surface, which in turn raises the prospect of public annoyance and creates health concerns.

SUMMARY OF THE INVENTION

According to a first aspect of the invention, there is provided a

process for clarifying water containing suspended solids comprising:

providing a quantity of contaminated water containing suspended solids;

pumping the contaminated water into a reactor;

injecting flocculating chemicals into the contaminated water into the reactor, thereby separating the contaminated water into grey water and flocculated mass;

separating the flocculated mass and the grey water; and

deodorizing the grey water.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 shows a flow chart of the waste treatment process.

FIGURE 2 shows a schematic diagram of an alternative embodiment of the waste treatment process.

FIGURE 3 shows the separator.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which the invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods and materials are now described. All publications mentioned hereunder are incorporated herein by reference.

Described herein is a process, system or method for treating waste, for example, for clarifying or otherwise treating water containing suspended solids. As discussed below, the flow rate of the water is increased by pump means and flocculating chemicals are injected into the contaminated water. The combination of pressure, turbulence and flocculating chemicals promotes rapid floc formation, in fact, almost instantaneously, causing the solids to come out of solution. The solids are then separated from the water, which is then filtered and deodorized. As can be seen, this process represents a significant improvement over processes known in the prior art which require batch treatments, large storage tanks or lagoons and the like in that the waste can be treated immediately and in fact takes on the order of minutes to be processed.

In an exemplary embodiment, discussed below, the waste is from a livestock barn, for example, a hog or swine barn, a feed or dairy cattle barn or a poultry barn. As will be appreciated by one of skill in the art, in these embodiments, the waste will consist primarily of manure but will also include hair, feed and the like.

In other embodiments, the process is used for flocculation of drilling fluids in the oil industry.

In yet other embodiments, the process is used to treat any suitable type of raw sewage.

As can be seen in Figure 1, in an exemplary embodiment wherein the waste is from a livestock barn, the waste treatment process comprises a livestock barn 10, a manure collection pit 12 in fluid contact with the barn, for

example, beneath the barn, a reactor 20, a separator 30, a dewaterer 40, a compost storage area 50, a high speed filter 60 and a deodorizer 70.

As will be apparent to one of skill in the art, in embodiments wherein other types of waste, for example drilling fluids or raw sewage, are treated, the waste is fed directly into the reactor 20 and the remaining steps are carried out as described below. However, for illustrative purposes, the use of the process in treating livestock waste is described below.

Livestock waste from the barn 10 is collected in the manure pit 12. Enzymes and/or microorganisms are added to the manure which promote breakdown or degradation of the waste. As will be appreciated by one of skill in the art, many suitable combinations of microorganisms and/or enzymes known in the art and are commercially available. The selection of the specific microorganisms and enzymes and combinations thereof will of course depend on the quantity, nature and condition of the waste and such selection can be done without undue experimentation and is within the scope of the invention. These may be used for degradation/breakdown of the waste and to prepare it for further processing, as discussed below.

In some embodiments, the waste barn 10 and/or the manure pit 12 is treated with a catalyst which promotes diffusion of digestive enzymes by the microorganisms. In one embodiment, the catalyst comprises saponins extracted from plants, for example, a commercial product named Home Farms Catalyst. Specifically, the catalyst increases the permeability of the cell wall of the microorganisms, thereby promoting diffusion of water, nutrients and digestive

enzymes into the waste. This in turn promotes liquefication of manure in the waste and reduces odor therefrom. That is, the more complete digestion of the waste made possible by the addition of the catalyst to the microorganisms keeps the malodorous gases dissolved in the liquid waste, thereby reducing odors emanating from both the liquid and solid portions of the treated waste, as described below.

The degraded waste, in the form of a slurry, is then transferred from the manure pit 12 to the reactor 20. In some embodiments, the slurry is shredded on exiting the manure pit 12, for example, by a shredder pump although other suitable means of homogenizing the waste may also be used. In one embodiment, on entry into the reactor 20, the flow rate of the slurry is increased to greater than about 100 gallons per minute, in some embodiments, approximately 100-180 or 100-170 or 100-150 gallons per minute. As will be appreciated by one of skill in the art, yet greater flow rates may be obtained by increasing the size and/or capacity of the reactor 20 and are within the scope of the invention. Once the flow rate has been increased, flocculating chemicals are added, as discussed below. Thus, the reactor 20 includes pump means for greatly increasing the flow rate or velocity of the slurry on entry into the reactor 20.

In an embodiment shown in Figure 2, the slurry is transferred from the manure pit to an initial separator or screening unit 90. The screening unit 90 separates undissolved or unsuspended solids from the slurry. In the embodiment shown in Figure 2, the screening unit comprises a separatory screen 92 and an auger 94. In use, the slurry flows over the screen 92 and undissolved solids larger than the mesh size of the screen 92 are retained by the screen 92. The solids on

the screen 92 are then passed to the auger 94 which transports the solids to a dewatering fan 96 where the solids are dried for subsequent use, as described below. It is of note that residual liquid removed from the undissolved solids can be recovered and used for other applications, for example, in the manure pit. Once the initial screen has been completed, the screened slurry is passed to the reactor 20 as discussed herein.

As will be apparent to one of skill in the art, while the content and texture of manure varies according to the specific animal as well as feed and living conditions, manure at a given livestock barn typically has largely consistent texture and chemical composition. As a consequence, the specific chemicals and concentrations thereof added to flocculate the slurry typically need only be determined once.

The reactor 20 may include a plurality of injector heads, for example, three injector heads, although of course the number may be varied in accordance with requirements. As a result of this arrangement, three separate chemicals each from a respective supply can be provided and injected into the reactor 20. Prior to injection, the chemicals are selected on the basis of conventional trials which determine from the composition of the waste water the best collection of chemicals in the best order and at the required amounts by setting up a series of trials on small samples of the waste water.

In a preferred embodiment, each of the injectors is associated with mixing means, for example, a paddle or beater bar which promotes mixing of the injected chemicals into the slurry.

It is of note that injector/mixer arrangements are known in the art and suitable such arrangements may be used within the reactor 20.

In some embodiments, the flocculating chemicals are selected from the group consisting of alum or aluminum salt, at least one suitable acrylic polymer and combinations thereof.

As will be appreciated by one of skill in the art, there are numerous polymers known in the art as flocculants. The suitability of specific polymers will of course depend on the nature of the waste being treated and determining which polymers would be suitable under given conditions is well within the skill of one knowledgeable in the art and could be determined without undue experimentation.

In one embodiment, the flocculating chemicals are injected into the slurry by injectors within the reactor 20. In other embodiments, pH modifying compounds, for example, a carbonate derivative, for example, soda ash and/or hot lime are injected into the slurry prior to the injection of the flocculating chemicals.

It is of note that in some embodiments, the viscosity of the slurry from the manure pit 12 may be such that water is added to the slurry so as to dilute the slurry prior to entry into the reactor. As discussed herein, this water may be water recovered from dewatered flocculated mass or may be treated grey water.

The combination of high flow rate and/or pressure, turbulence and flocculating chemicals promotes rapid floc formation, transforming the slurry into flocculated mass in grey water. Specifically, "flocculated mass" refers to the material or solids that has fallen out of the slurry as a result of the exposure to the flocculation chemicals and increased pressure and/or flow rate and turbulence;

"grey water" refers to the water transporting the flocculated mass, that is, the water in which the flocculated mass is suspended. it is of note that as discussed above, an advantage of the instant process is that the time of residence of the slurry within the reactor is very short and the combination of high flow rate and injected chemicals promotes rapid in-line floc formation. This means that the waste is effectively treated in "real time" and there is no incubating or batching once the waste is pumped from the reactor 20. That is, unlike the prior art systems, there is no mixing tank, batch tank or settling tank wherein flocculation must be allowed to occur over a period of time with periodic mixing and settled solids are subsequently removed. In the instant invention, flocculation occurs within the reactor virtually instantaneously with injection of the flocculating chemicals and the slurry is pumped immediately and directly to the separator 30.

The flocculated mass is then passed to the separator 30 which is arranged to separate the flocculated mass from the grey water. As will be appreciated by one of skill in the art, there are many suitable separators known in the art, for example, but by no means limited to, the Resource™ and the Pre-Screen (World Water Works), REDUX™ Dissolved Air Flotation (Milieu-Nomics Inc.), Wedge Wire Screens™ (Tri-Wire Corporation), Sta-Sieve Screen™ (SWECO), Spirosep Separator™ (Spirac Corporation), Screen Separator (Star Trace Manufacturing), Screw Separator (Kason) and Screen Separator (Flo Trend Systems).

In one embodiment, shown in Figures 2 and 3, the separator 30 comprises a tapered section 32, an inner wall 34, a concave screen 36 and an

auger 38. The flocculated mass and grey water is transported along the tapered section 32 which is a trough that as can be seen in Figure 3, is wider and deeper at the junction with the reactor 20 but becomes progressively more narrow and shallow along the width of the separator 30. As a result of this arrangement, the flocculated mass in grey water leaving the reactor is decelerated and the flocculated mass in grey water is forced upward along the inner wall 34. Once the flocculated mass and grey water extends above the height of the inner wall 34, the flocculated mass and grey water spills over the inner wall 34 and onto the concave screen 36. The concave screen 36 is mounted within the separator 30 at an angle and has a curved bottom portion. As a result of this arrangement, the flocculated mass remains on the screen while grey water passes through the screen and is passed to a filter, as described below. The pressure exerted by incoming flocculated mass on flocculated mass already on the concave screen 34 moves the flocculated mass downward and also has a dewatering effect by pressing the flocculated mass against the screen 36. Thus, flocculated mass passes over and is pressed against the concave screen 36, thereby dewatering the flocculated mass. On reaching the bottom of the concave screen 36, the flocculated mass tumbles down onto the auger 38. It is of note that while in the illustrated embodiment an auger is used, any suitable means of conveyance may be utilized to transport the flocculated mass.

It is of note that the concave screen 36 may be mounted within the separator 30 such that the concave screen 36 pivots, for changing the angle or slope of the concave screen 36 within the separator 30.

It is further of note that in some embodiments, the concave screen 36 may comprise a very fine mesh for separating other waste, for example, hair, from the slurry.

In another embodiment, the flocculated mass and grey water is transported from the reactor 20 to the separator 30 as described above. However, on reaching the separator 30, the flocculated mass and grey water is directed into a channel arranged to induce turbulence into the flocculated mass and grey water, thereby inducing further flocculation. As will be appreciated by one of skill in the art, the channel may be arranged in any suitable design that maximizes the surface area to which the flocculated mass and the grey water is exposed and/or the travel time for the flocculated mass and the grey water from the base of the separator 30 to the screen 36, described above. For example, in one embodiment, the channel has a substantially "S" like shape, that is, the channel extends from one side of the separator 30 to the other side of the separator 30; in some embodiments, this pattern may be repeated several times, thereby increasing turbulence and flocculation.

As shown in Figure 1, the separated flocculated mass is passed along the auger 38 to a dewaterer 40. As will be appreciated, any suitable dewatering device known in the art, for example, a screw press, may be utilized. Other suitable dewaterers include but are by no means limited to the following commercially available dewaterers: Dewater Auger (World Water Works), Separators (GEA Westfalia Separator), Centrifuges (Alfa Laval), Press Separator (CAWI Canada), Press Screw Separator (FAN-Separator), PRS Screw Press

(IPEC) and Dewatering Unit (Sleegers). Once dewatered, the flocculated mass is stored in a compost storage area 50 while the water extracted from the flocculated mass by the dewaterer 40 may be used for any suitable purpose, for example, for further treatment or returned to the barn 10 or manure pit 12 for further use in the process. It is further of note that as discussed above, treatment of the waste in the barn 10 or the manure pit 12 with the catalyst greatly reduces odors, meaning that the compost is not significantly malodorous.

As discussed above, the grey water is passed from the separator 30 to a high speed filter 60. In some embodiments, the filter 60 is a backwash filter. Specifically, the filter 60 acts to remove fine particles, such as hairs and silt, from the grey water. Once there is sufficient build-up, the pump reverses and expels the removed material to the manure pit 12.

The filtered grey water is then passed from the high speed filter 60 to a deodorizer 70. In one embodiment, the deodorizer comprises a granular media bed comprising a clay substrate impregnated with oxides of iron. The grey water is passed through the bed and the oxides of iron act to remove ammonia, hydrogen sulphide and light mercaptan gases dissolved and/or dispersed in the grey water. The bed also removes finely dispersed solids. In some embodiments, the deodorizer also includes a carbon foam filter. As will be appreciated by one of skill in the art, other suitable deodorizers known in the art may also be used.

Once passed through the high speed filter 60 and the deodorizer 70, the grey water is clear and odorless and can be used for any suitable purpose. The grey water may be stored in a reservoir 80 for subsequent use, as discussed

herein.

Thus, the above-described process is arranged to quickly clarify contaminated water. Specifically, the waste from the manure pit is processed rapidly without batching. This is made possible by the combination of pressure, turbulence and injected flocculants in the reactor, which causes floc formation to occur virtually instantaneously. The flocculated mass including grey water is then pumped directly to a separator wherein it is separated into grey water and flocculated mass without settling as is the case with prior art methods.

While the preferred embodiments of the invention have been described above, it will be recognized and understood that various modifications may be made therein, and the appended claims are intended to cover all such modifications which may fall within the spirit and scope of the invention.